Functional neuroanatomy of the neurological examination

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Peripheral neuropathy

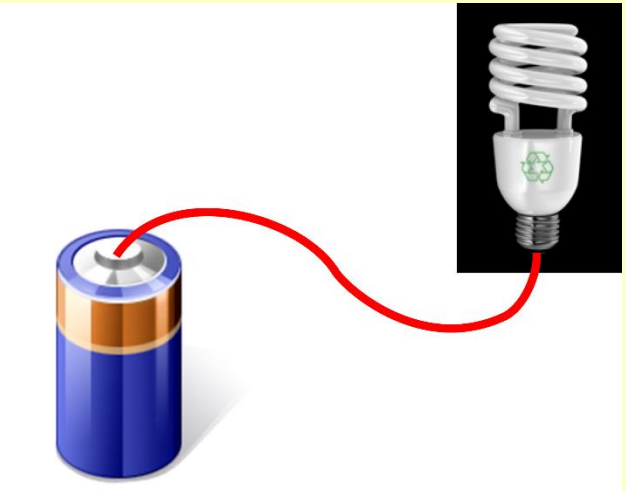
The Neuro Exam

- What do we assess?

1. Mentation/arousal and behaviour
2. Posture and gait
    1. Sensory function
        1. posture, proprioception, tactile
    2. Motor function
        1. posture, gait, spinal reflexes
    3. Coordination
    4. Balance
3. Cranial nerves
4. Visceral function
5. Nociception
6. Spinal pain-hyperpathia

Two principles

- Lesion location on a pathway
- Normal and abnormal signs



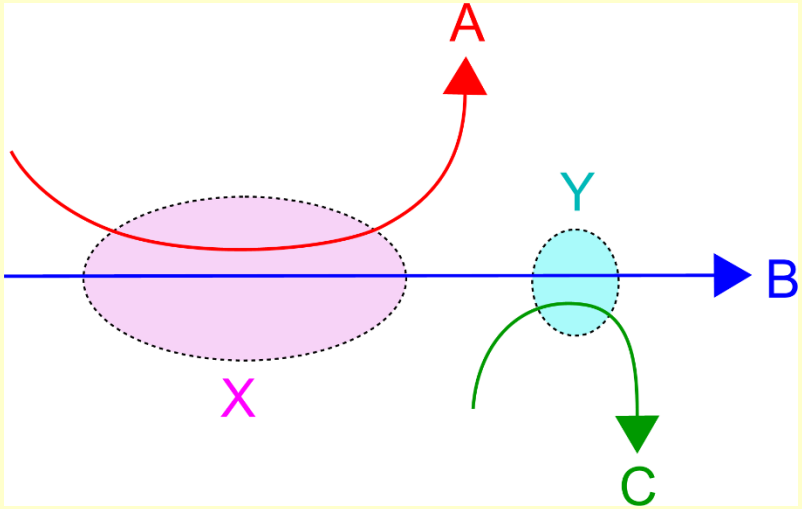


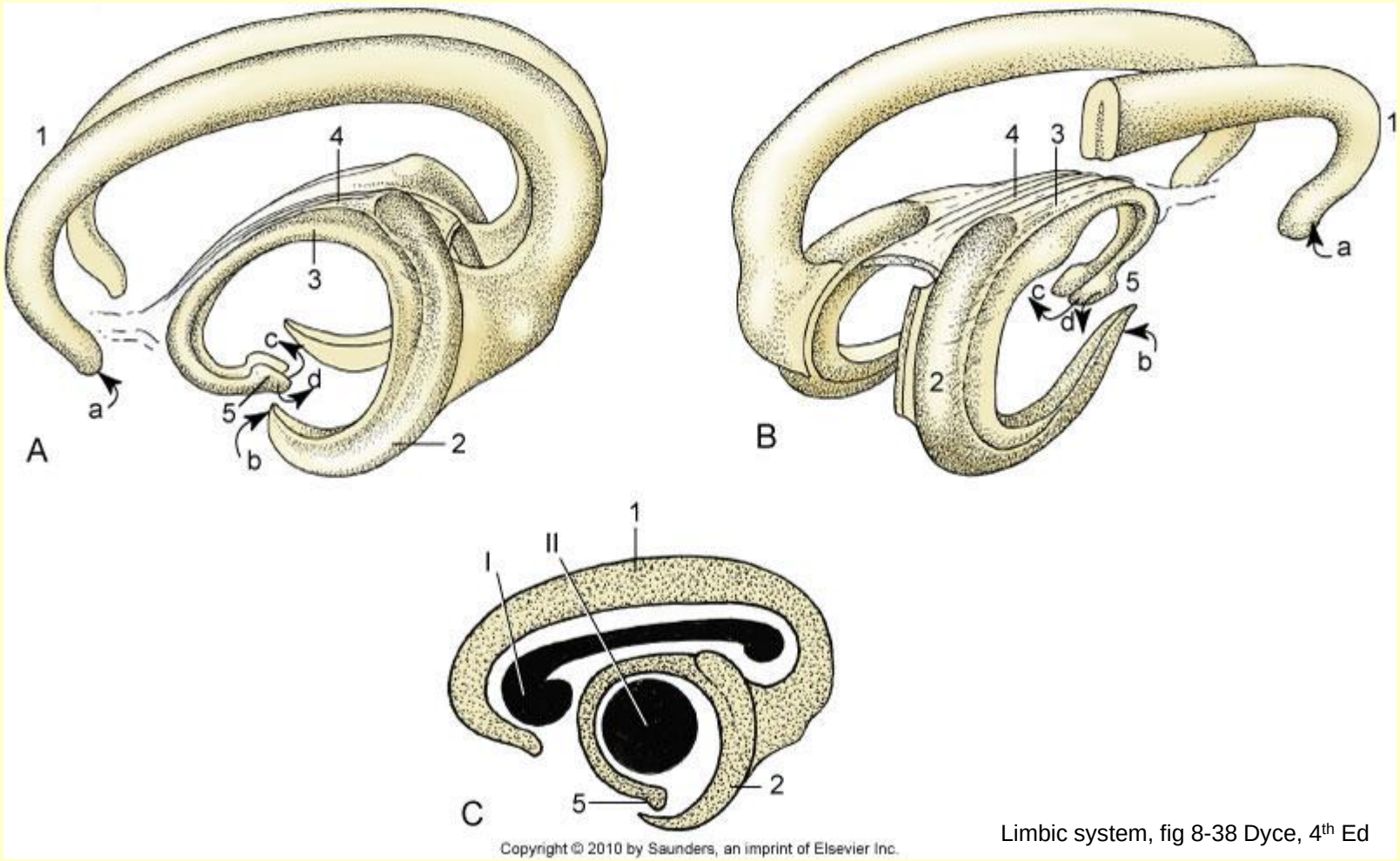
Fig 13.1 Thomson and Hahn

Behaviour and mentation

Limbic system

- Function – visceral processes associated with display of emotion, memory, behaviour, personality
- Location – on limbus (border) between telencephalon and diencephalon
- Gyri – hippocampus, parahippocampal, cingulate, subcallosal, dentate
- Nuclei – septal, amygdaloid, thalamic, hypothalamic, habenular, interpeduncular (intercrural), mammillary body,
- White matter – fimbria and fornix, stria terminalis, medial forebrain bundle

Fig 11.1 Thomson and Hahn The limbic system



Limbic system, fig 8-38 Dyce, 4th Ed

1 Supracallosal and cingulate gyrus
2. Hippocampus
3. Fornix
4. Commissure of fornix
5. Mamillary body

a. input from medial olfactory tract
b. input from piriform lobe
c. output to mamillothalamic tract
d. output to brainstem

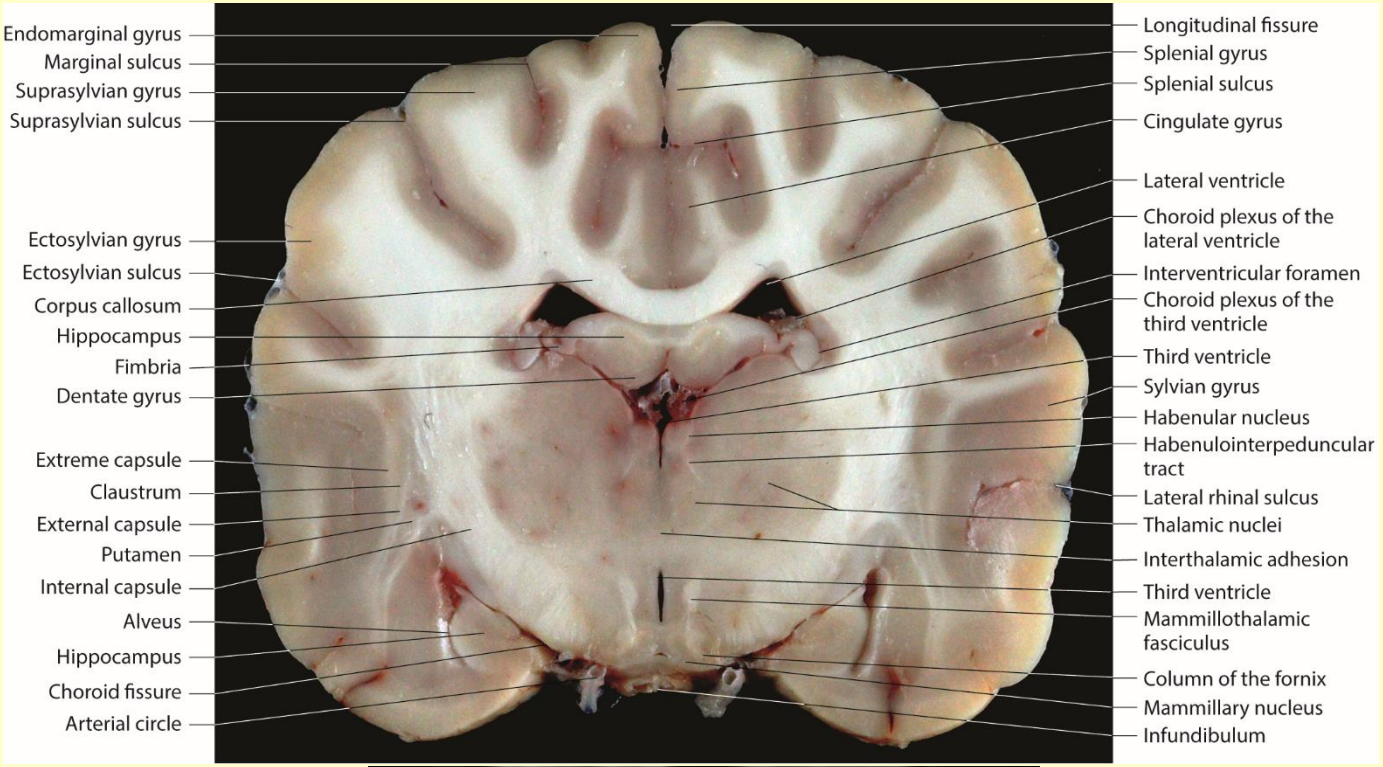
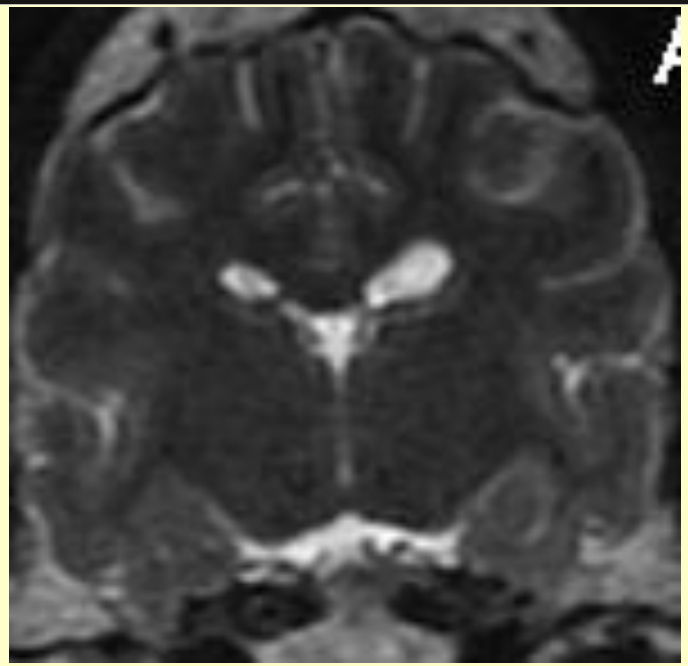


Fig A16 Thomson and Hahn



Arousal

- Ascending reticular activating system (ARAS)
  - Location
    - Myelencephalon to diencephalon
  - Input
    - Copies of all afferent information (except muscle and joint proprioception)
  - Pathway via thalamus
  - Diffuse projection to cerebrum
    - General stimulation/wake-up call
  - Triage unit
    - Sorting out important information from background noise.

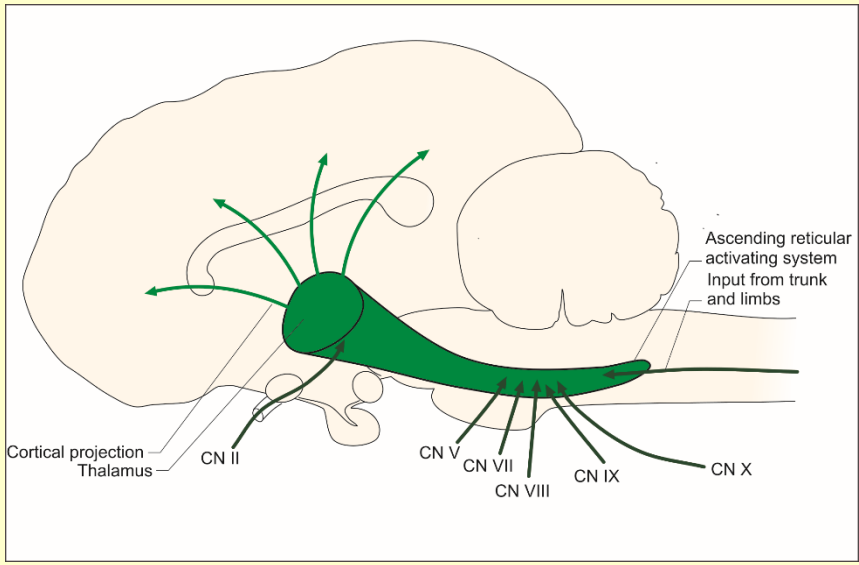


Fig 11.2 Thomson and Hahn, ARAS

Functional neuroanatomy of posture and gait

Functional neuroanatomy of posture and gait

- What's involved in normal gait?
- Sensory systems
  - Proprioception from all of body including head (vestibular system)
- Motor systems
  - Planning, UMN, LMN, muscle
- Reflexes
- Central pattern generators
- Coordinating system

Sensory systems

Sensory input

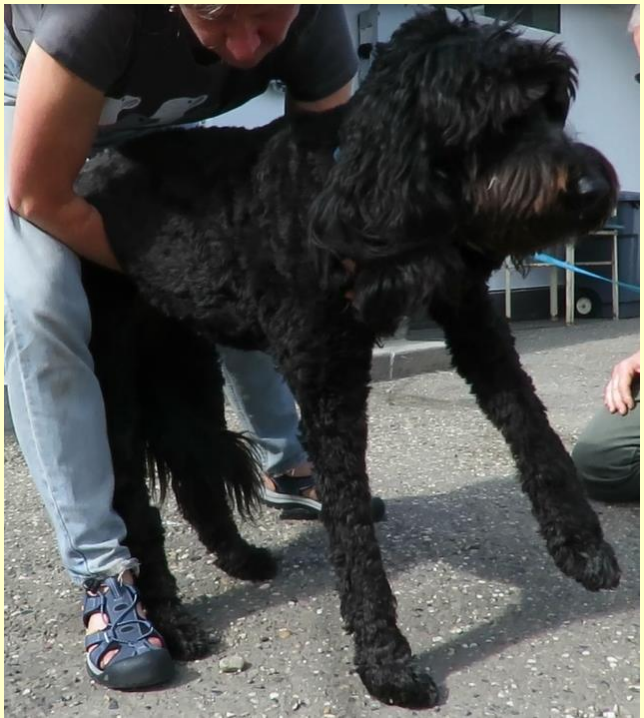
- Exteroceptors
  - Tactile, thermal, special senses
- Interoceptors
  - Viscera – pH, stretch, ischaemia
- Proprioceptors
  - Body and limbs
    - Muscle spindles, Golgi tendon organs, tactile
  - Head proprioception
    - Vestibular system

Proprioception

- Definition
  - Latin *proprius* = one's own

Conscious proprioception

- Used in voluntary, skilled movement
  - Tactile receptors
  - Limbs, trunk, tail, neck
- Projection to contralateral cerebrum
- Tracts in dorsal and lateral funiculus
  - Fasciculus cuneatus – cranial to T8
  - Fasciculus gracilis – caudal to T8
  - Dorsal spinocerebellar to nucleus Z – lateral funiculus
- Testing
  - Test tactile receptor function
    - Posture
    - Paw position response
    - Hopping



Subconscious proprioception

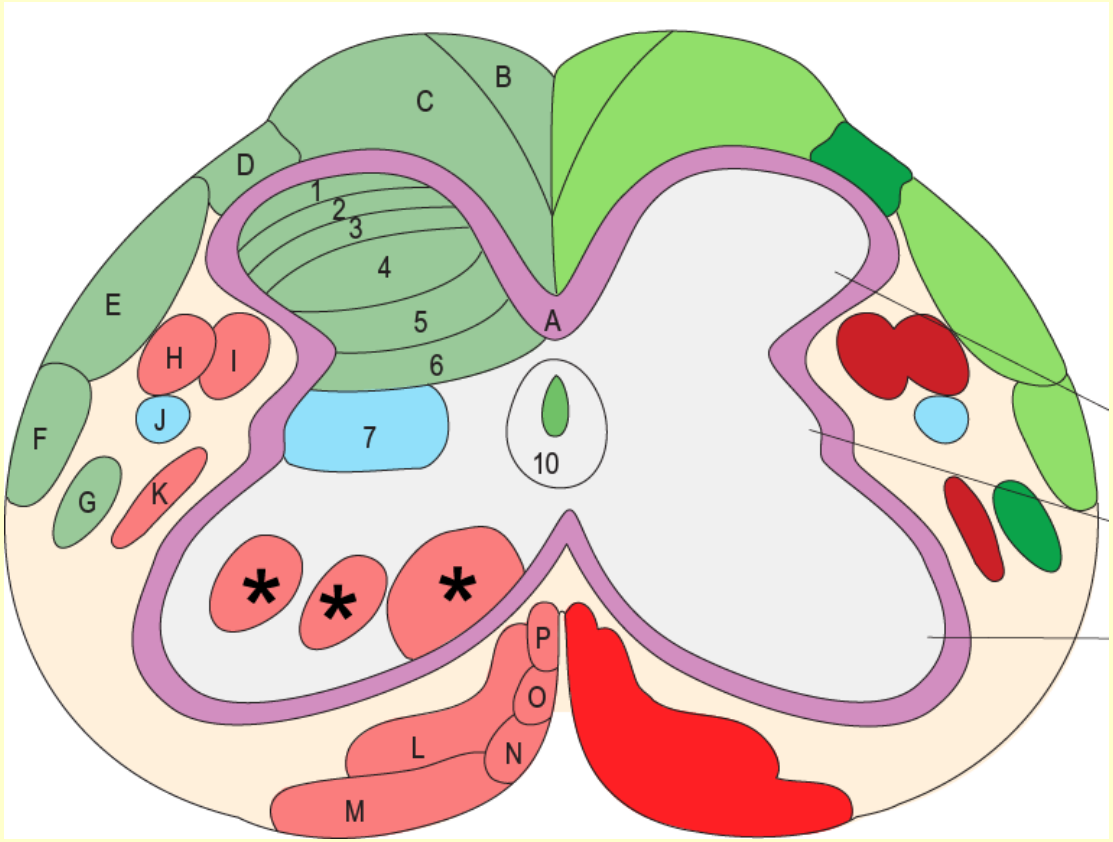
- Used in posture and gait
  - Set limbs (props) under centre of gravity
  - Muscle stretch receptors, joints, tendons
- Projection to
  - Ipsilateral cerebellum
  - (Somatosensory cortex – kinaesthesia)
- Lateral funiculus
  - Spinocerebellar tracts (several)
  - Copies via nucleus Z and X, medial longitudinal fasciculus to contralateral somatosensory cortex for kinaesthesia
- Testing
  - Test muscle stretch receptor function
  - Posture – SCPD base wide, base narrow
  - reflex step
  - hopping

Hopping test

General proprioception

= conscious and subconscious proprioception

Reflex step test



ID	Name
A	Propriospinal (spino-spinal)
B	Fasciculus gracilis
C	Fasciculus cuneatus
D	Dorsolateral fasciculus
E	Dorsal spinocerebellar
F	Ventral spinocerebellar
G	Spinothalamic

Fig 4-5 Thomson and Hahn

Proprioceptive tracts

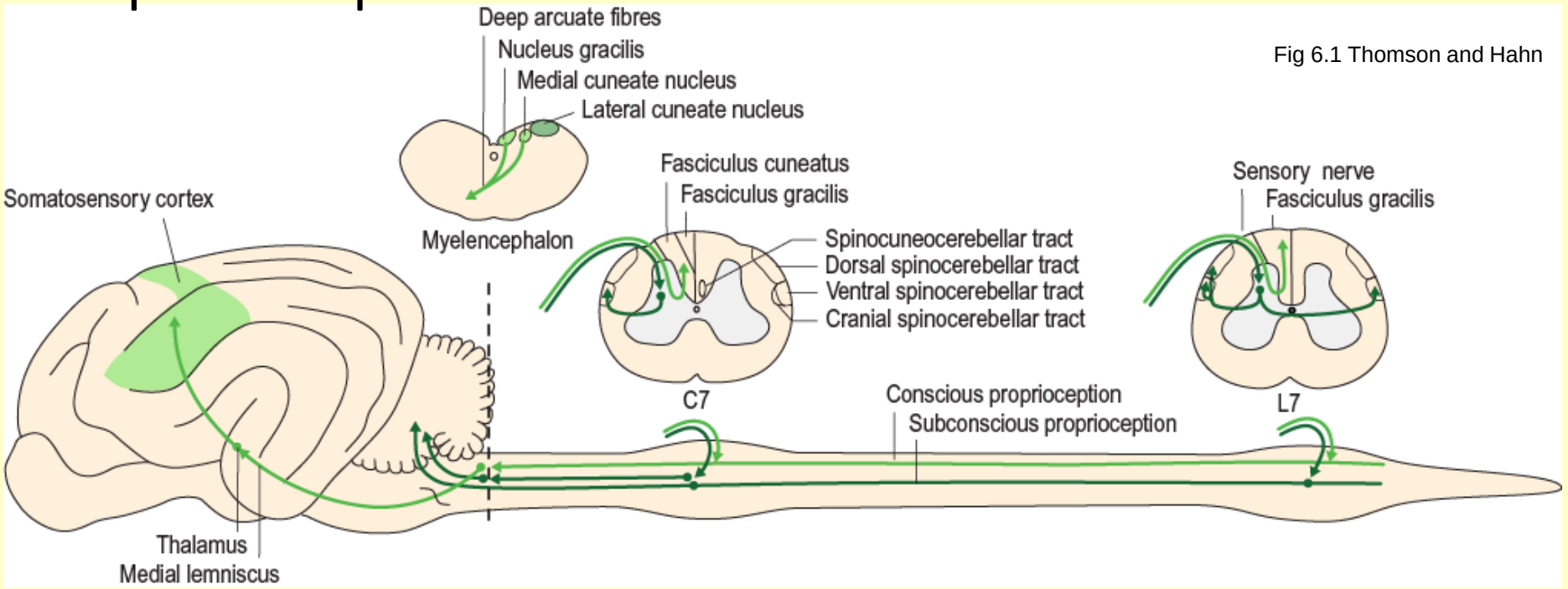


Fig 6.1 Thomson and Hahn

CP pathways – (DF and LF) to contralateral somatosensory cortex

Dorsal column – medial lemniscal system

- Caudal ½ of body (caudal to T8)
  - fasciculus gracilis to cranial lumbar, then majority transfer into DSCT, nucleus Z (near gracile n.) medial lemniscus, thalamus, somatosensory cortex
- Cranial ½ of body
  - fasciculus cuneatus, medial cuneate nucleus, medial lemniscus, thalamus, somatosensory cortex

SCP pathways to ipsilateral cerebellum: Synapse at base of dorsal horn,

- Caudal ½ of body
  - dorsal and ventral spinocerebellar tracts lateral funiculus
- Cranial ½ of body
  - spinocuneocerebellar (via fasciculus cuneatus to synapse in lateral cuneate nucleus)
  - cranial spinocerebellar tracts (synapse in base of dorsal horn) then via lateral funiculus

Kinaesthesia – conscious awareness of limb position and movement

- Collaterals of SCP via nucleus Z and X (near lateral cuneate n.), medial lemniscus, thalamus, somatosensory cortex

Proprioceptive deficits

- Differentiation
  - Consider a lesion at tract termination, what proprioceptive deficits do you see in a cerebellar versus cerebral lesion?
- SCP
  - Ataxia, base wide/narrow, circumduction/abduction,
  - Delayed initiation/termination
  - Truncal sway
  - Paw position response normal
- CPD
  - Abnormal foot position (knuckling) but limbs under centre of gravity
  - Minimal ataxia
- General proprioceptive deficit
  - CPD and SCPD


SCPD Cerebellar case


CPD – forebrain tumour


General PD - neuropathy


General PD – C1-5 lesion

Testing tactile sensation

Sensory zones

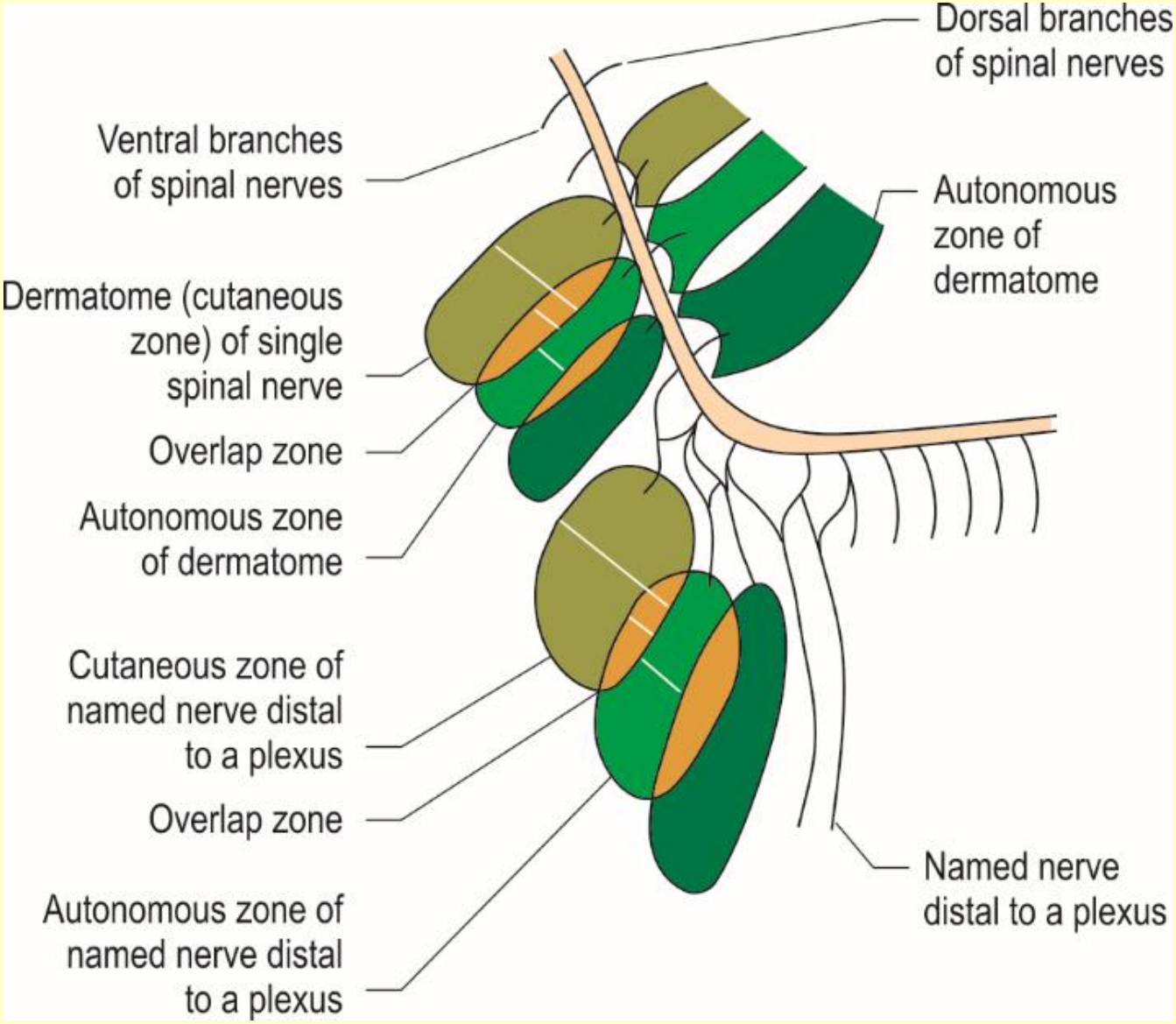
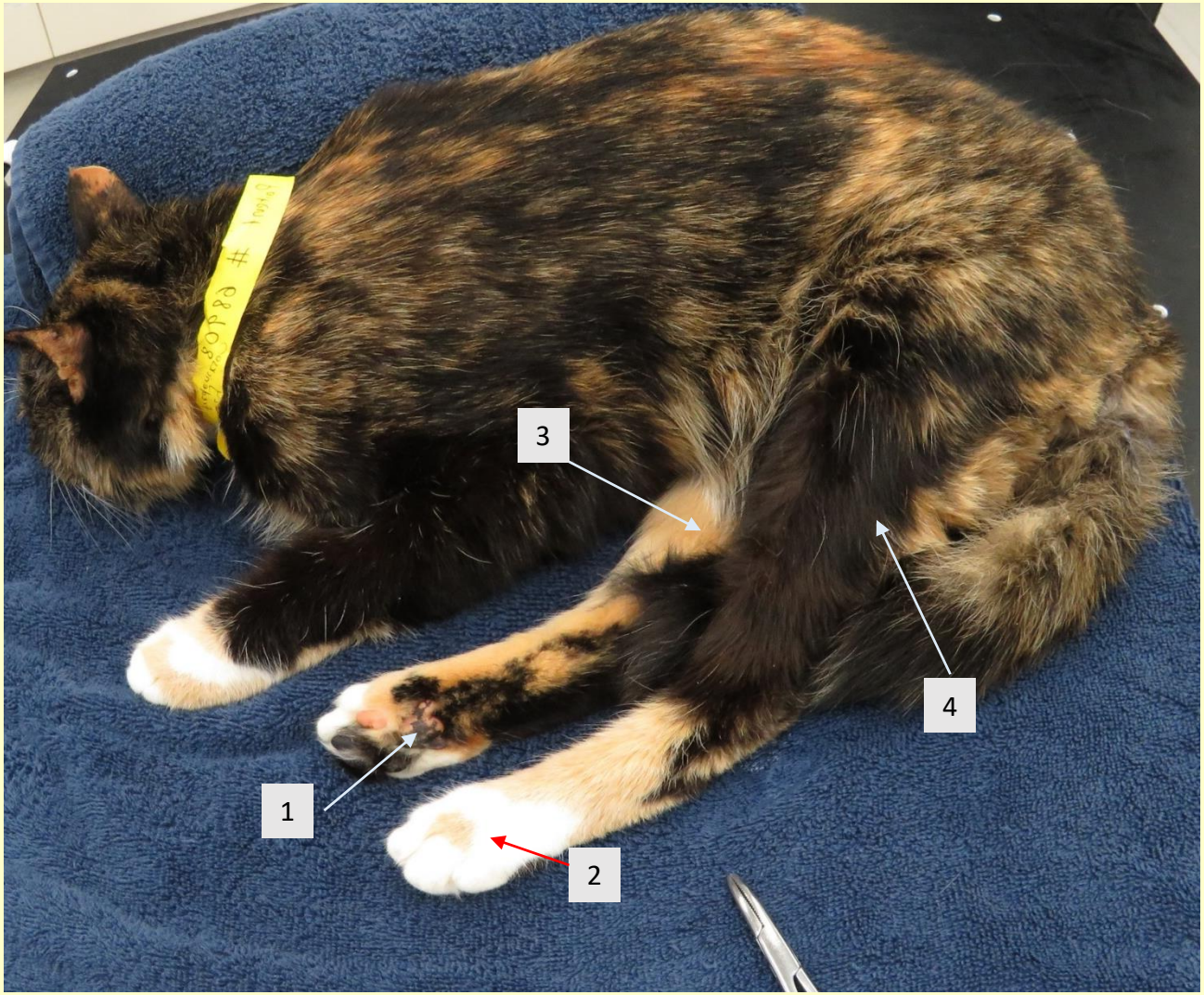


Fig 1.3 Thomson and Hahn

To test the autonomous zone of the saphenous nerve in the cat, you would test region…



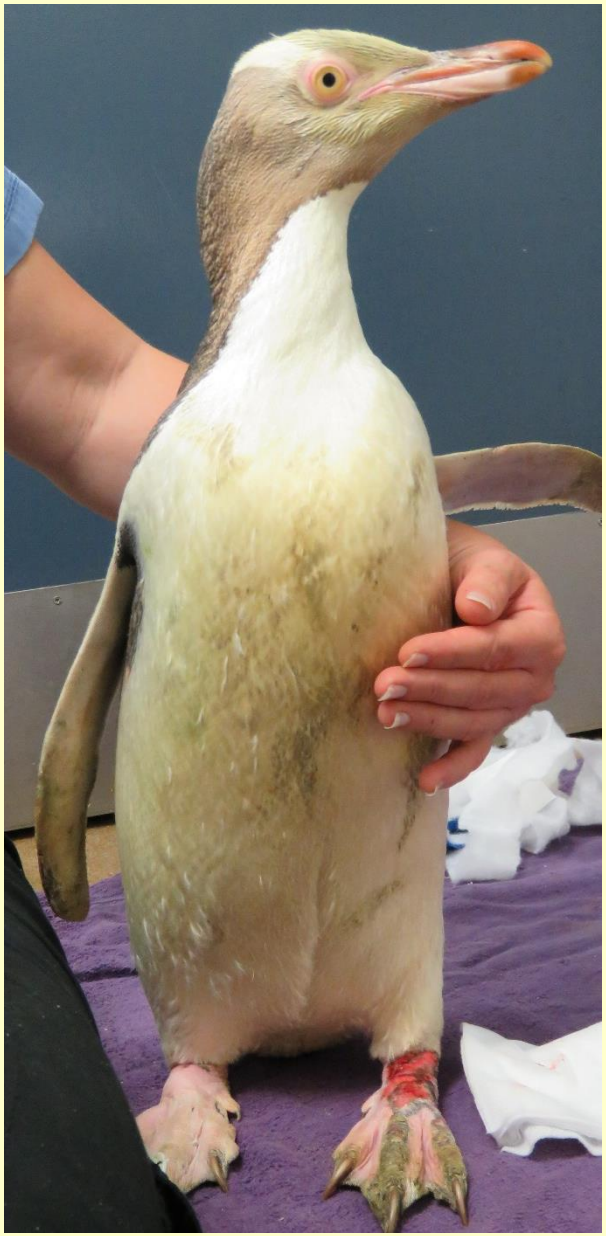
Autonomous zone testing

1. Peroneal n.
2. Saphenous n.
3. Tibial n.
4. Radial n.
5. Ulnar nerve
6. Branches of CN V
7. Musculocutaneous n.

- What about the axillary and pudendal nerves?

Pain definition

- Pain
  - Sensory component
    - Nature, quality, duration
    - Somatosensory cortex
  - Affective component (emotional)
    - How disturbing it is
    - Limbic system
  - ‘An unpleasant sensory and emotional experience associated with actual or potential tissue damage…’
    - (IASP: Int. Assoc. for the Study of Pain)



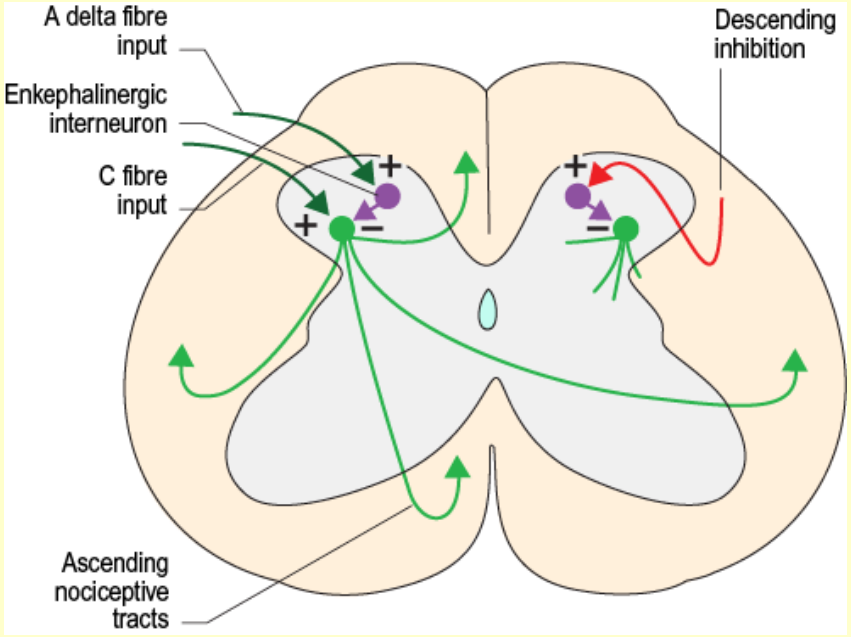
Nociceptors

- Type
  - Stimuli
    - Mechanical, thermal, chemical
    - Unimodal
    - Polymodal
  - Nociceptors = naked nerve endings
  - Superficial and deep structures
    - Different pathways
  - Silent nociceptors
    - Normally, only stimulated by intense stimuli
    - threshold reduced by inflammation
    - Inflammation leads to hyperalgesia

Post dog mauling

Nociceptive fibers

- Aδ
  - 5-30 m/sec (light myelin)
  - Localising, pinprick stimuli
  - Spinocervicothalamic to somatosensory cortex
  - Aim: Remove body from noxious stimulus
- C
  - 0.5-2m/s (non-myelinated)
  - Slower, burning pain
  - Aversive dull, aching, throbbing
  - Spinoreticulothalamic to limbic system
  - Aim: Withdraw and rest, healing
- Ratio
  - Somatic 1:2 (superficial)
  - Visceral 1:10 (deep)



Thomson and Hahn, fig 6.5

Nociception

- Reflex
  - Neuroanatomy?
  - Example?
- Reaction
  - Neuroanatomy?
  - Example?
- Autonomic effects
  - What changes are stimulated?
  - Mechanism

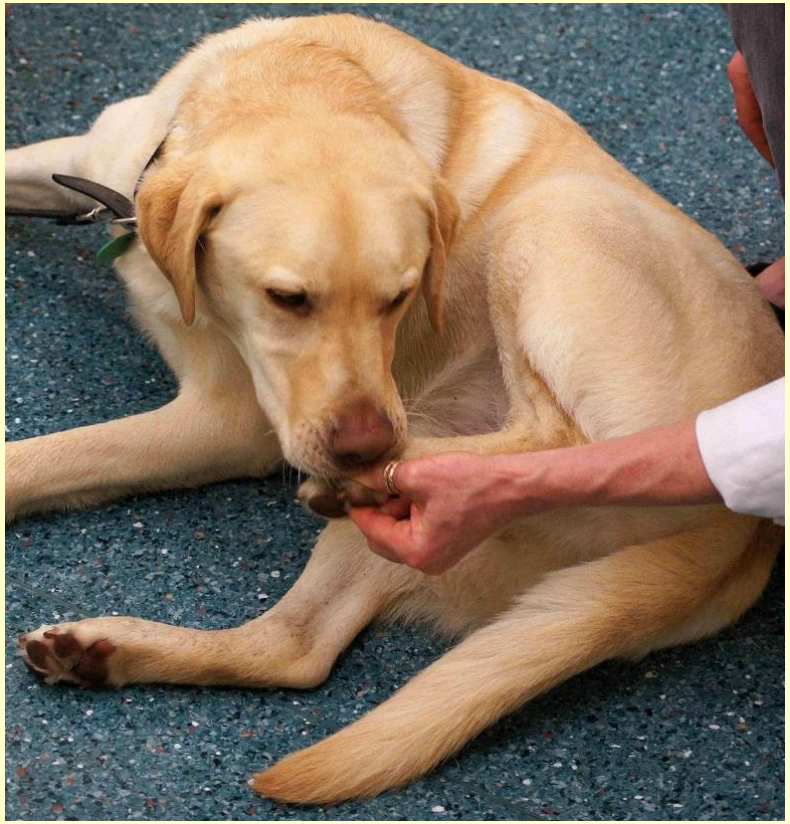


Fig 13.10 Thomson and Hahn

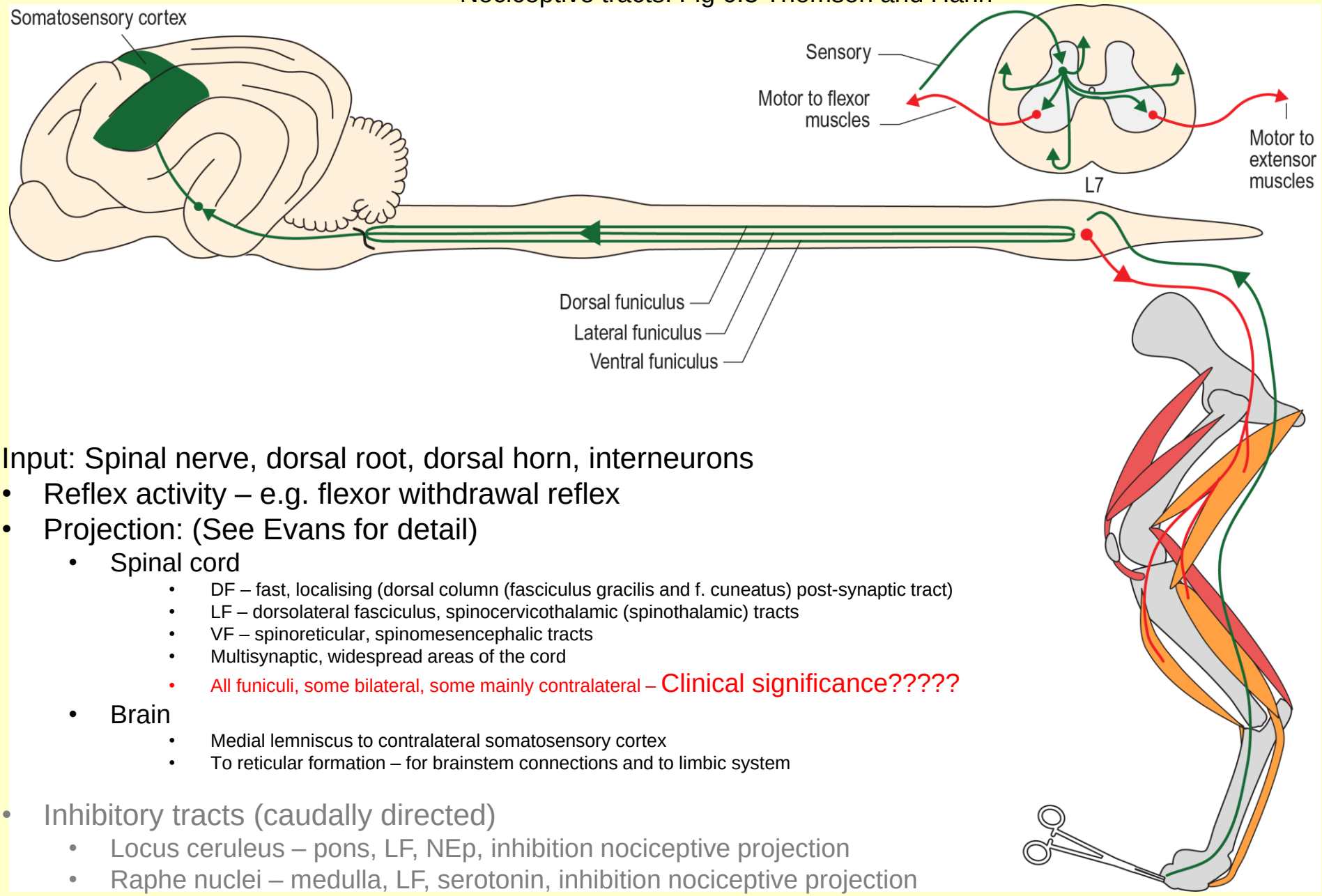
- Distinction between nociception and pain perception

Head nociception

- Input?
- Nerve cell bodies – location
- Synapse in sensory nucleus of V
- Connections?

Fig 13-12, Thomson and Hahn

Nociceptive tracts: Fig 6.3 Thomson and Hahn



Input: Spinal nerve, dorsal root, dorsal horn, interneurons

- Reflex activity – e.g. flexor withdrawal reflex
- Projection: (See Evans for detail)
  - Spinal cord
    - DF – fast, localising (dorsal column (fasciculus gracilis and f. cuneatus) post-synaptic tract)
    - LF – dorsolateral fasciculus, spinocervicothalamic (spinothalamic) tracts
    - VF – spinoreticular, spinomesencephalic tracts
    - Multisynaptic, widespread areas of the cord
    - All funiculi, some bilateral, some mainly contralateral – Clinical significance?????
  - Brain
    - Medial lemniscus to contralateral somatosensory cortex
    - To reticular formation – for brainstem connections and to limbic system
- Inhibitory tracts (caudally directed)
  - Locus ceruleus – pons, LF, NEp, inhibition nociceptive projection
  - Raphe nuclei – medulla, LF, serotonin, inhibition nociceptive projection